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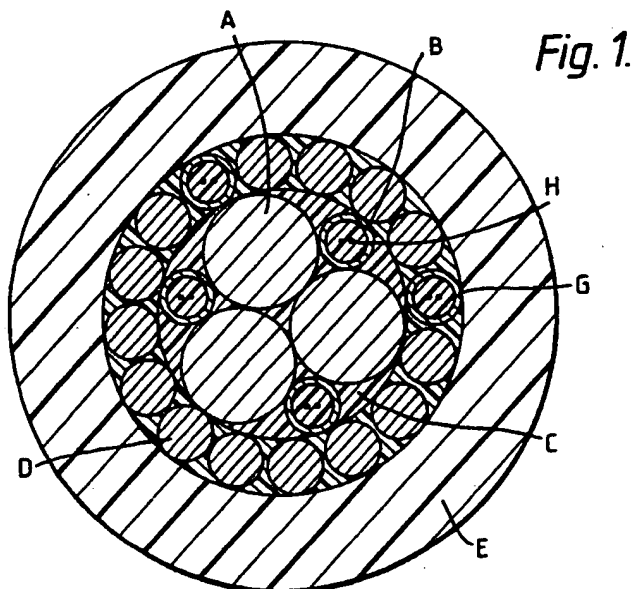
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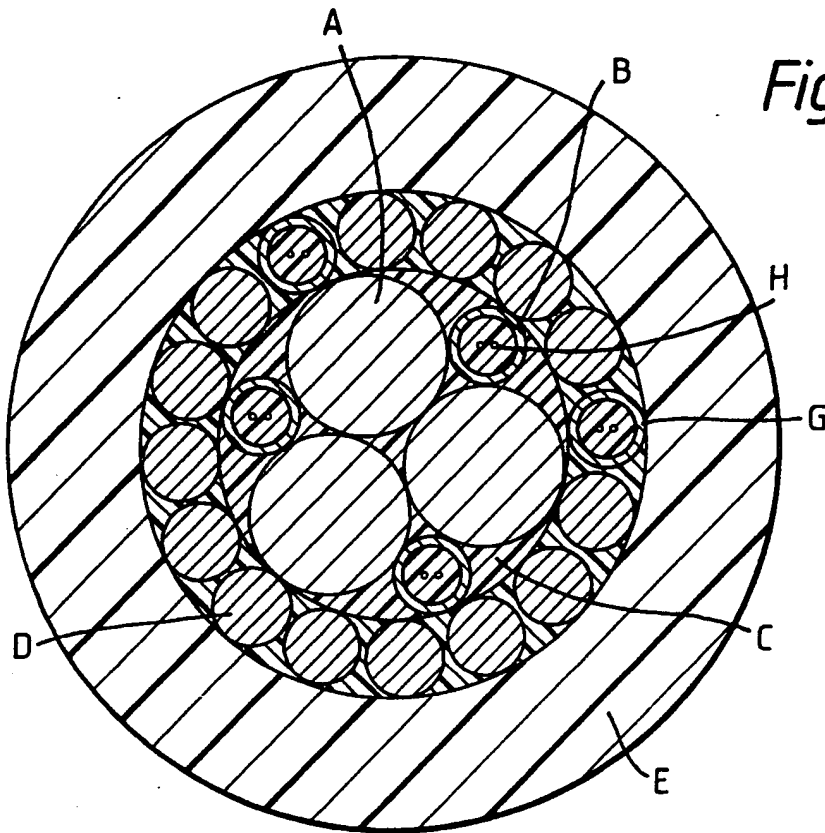
(54) Optical fibre cable having an optical fibre in a welded metal tube

(57) An optical fibre cable comprises a helical stranded core of at least two strength members A. Within the interstices of these strength members A is at least one longitudinally welded, metallic tube B within which is encased at least one optical fibre H. At least one additional strength layer D is interposed between the core and an outer sheath E.

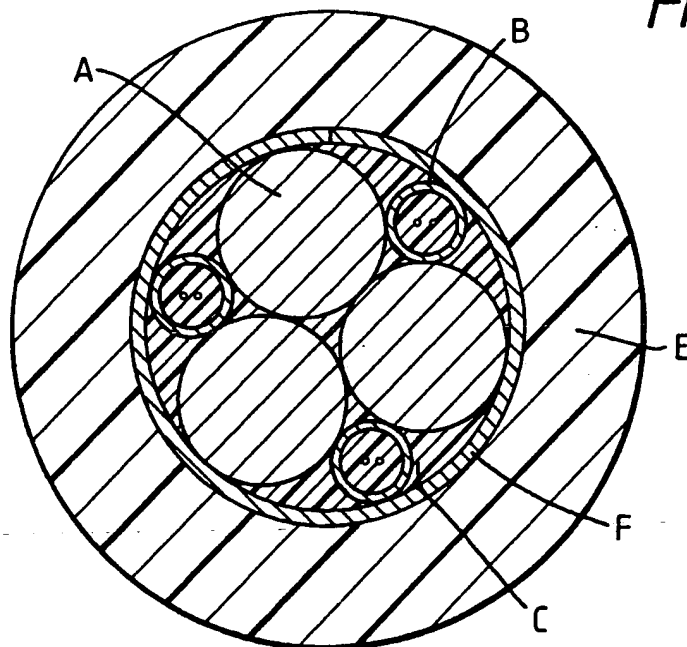
The additional strength layer may comprise helically wound longitudinal strength members D or a rigid tube (F, Fig. 2). The layer of helically wound strength members D if used, can also incorporate at least one longitudinally welded metallic tube G, containing within it at least one optical fibre. Water-blocking compound C may be present.



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*Fig. 1.*



*Fig. 2.*

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OPTICAL FIBRE CABLE

This invention relates to optical fibre cables, and especially, though not exclusively, to cables for use in underwater applications.

Underwater cables are required to have high strength and be resistant to high pressures, the action of the sea and damage from vessels. Conventionally, such cables are constructed with a fibre package protected by a seamless metal tube and helical layers of armouring wires. The metallic elements are insulated and protected by a thick polythene sheath. Where repeaters are needed, the power to the repeaters is supplied from the metallic elements. If the polythene sheath is damaged, there is a risk of the metallic elements being earthed. Also, in order to provide a satisfactory mechanical structure for the cable the wires around the core need to be either of large size or be present in large numbers. The combined effect of the armouring wires and sheath is to produce a heavy and unwieldy cable.

It is an object of this invention to provide a cable which is smaller and lighter than conventional cables, whilst providing enhanced cable crush protection.

Accordingly the invention provides an optical fibre cable comprising, within an outer sheath, a stranded core of at least two

strength members having, within the interstices of these members, at least one longitudinally welded metal tube within which is encased at least one optical fibre and, surrounding the core, at least one additional strength layer interposed between the core and the outer sheath.

The radial reaction required to reduce the possibility of damage to the metal tube or tubes is provided in part by the strength members of the core.

However, the presence of the additional strength layer or layers provides additional crush protection as well as a radial reaction force to resist movement of the stranded core members. The risk of crushing the metal tube or tubes in the peripheral interstices of the core is therefore virtually eliminated.

The additional strength layer may comprise a plurality of longitudinal strength members wound helically around the core, members of the additional layer and the core members preferably being wound helically in opposite directions for cancellation of the torsional effect.

However where the weight of the cable needs to be kept as low as possible, then the additional strength layer may be provided by a rigid tube conveniently formed from a strip of metal folded longitudinally around the core. Alternatively, the rigid tube may be of a high modulus polymeric matrix material. In either case the outer surface of the rigid tube is conveniently cylindrical.

The outer sheath is preferably formed of a suitable extrudate plastic material.

The longitudinally welded metal tube or tubes of the core is/are preferably laser welded.

Preferably each metal tube containing one or more optical fibres is located within a respective one of the peripheral interstices between adjacent strength members. In such a case the diameter of the or each said metal tube is preferably such that the tube does not extend radially beyond the circle circumscribing the assembly of longitudinal strength members.

Where the core incorporates a plurality of said metal tubes they are preferably all of uniform diameter. Conveniently, any metal

tube may be built up to the desired diameter with a non-metallic outer layer. The buffer layer may additionally or alternatively be used as a means of identification.

Where the additional strength layer comprises helically wound strength members one or more metallic tubes, each containing at least one optical fibre and preferably laser welded, may also be interspersed between the members of such an additional strength layer, the tube or tubes preferably being of the same diameter as the members.

A water blocking compound may be provided between the strength members and metal tubes of the core, and also, if required, between the strength members and any additional tubes of the additional strength layer. In addition a water blocking compound, such as a thixotropic grease, may be provided within the welded metal tubes containing optical fibres.

The strength members of the core are conveniently in the form of metal wires, e.g. of steel, although where the additional strength layer is provided by helically wound strength members these may be of a high modulus plastics material e.g. Aramid polymer.

In addition to the metallic tube or tubes containing optical fibres a cable may incorporate at least one conductor for carrying electrical signals or power. Such a conductor may be disposed in the interstices of the stranded strength members, and preferably is covered with an electrically insulating layer. Such a conductor may be used, for example, to pass electrical signals or electrical power to in line repeaters, regenerators and/or amplifiers.

Two embodiments of the invention will now be described by way of example with reference to Figures 1 and 2 of the accompanying diagrammatic drawings which represent cross sections through two optical fibre cables embodying the invention.

The cable illustrated in Figure 1 comprises a central core incorporating stranded strength members A in the form of steel wires, and laser welded metallic tubes B, for example of stainless steel, each containing one or more optical fibres as at H, and disposed in the peripheral interstices of the strength members A. The diameter

of the metallic tubes B is such that they do not extend radially beyond the circle circumscribing the stranded strength members A. Surrounding the strength members A and the metallic tubes B is shown an additional layer of strength members D which may also be in the form of steel wires, with further laser welded stainless steel tubes G containing optical fibres interspersed between some of the additional strength members D, the diameter of the tubes G being no greater and preferably being the same as that of the members D.

Between the strength members A and D and the metallic tubes B and G there is provided a water blocking compound C, a water blocking compound also being provided within the metallic tubes containing optical fibres.

The assembly of strength members and metallic tubes is surrounded by an outer sheath E of polyethylene.

The lay of the helically wound central strength members A and tubes B is opposite to that of the additional strength members D and tubes G.

Figure 2 is a cross section through an optical fibre cable embodying a variation of the invention. This comprises a structure similar to that of Figure 1 with the same elements denoted by the same reference letters, namely strength members A, metallic tubes B, water blocking compound C. In this case, however, the additional layer of strength members D, and tubes G has been replaced by a 'C'-section rigid tube F formed by folding a metallic strip longitudinally around the central core.

In each of the embodiments described the metallic tubes B, G may be individually surrounded by a plastic layer.

CLAIMS

1. An optical fibre cable comprising, within an outer sheath, a stranded core of at least two strength members having, within the interstices of these members, at least one longitudinally welded metal tube within which is encased at least one optical fibre and, surrounding the core, at least one additional strength layer interposed between the core and the outer sheath.
2. A cable according to Claim 1 wherein the additional strength layer comprises a plurality of longitudinal strength members wound helically around the core.
3. A cable according to Claim 2 wherein strength members of the additional layer and those of the core are wound helically in opposite directions.
4. A cable according to Claim 2 or 3 incorporating one or more metallic tubes, each containing at least one optical fibre, interspersed between members of the additional strength layer.
5. A cable according to Claim 1 wherein the strength layer comprises a rigid tube.
6. A cable according to Claim 5 wherein the rigid tube comprises a metal strip folded longitudinally around the core.
7. A cable according to Claim 5 wherein the rigid tube is of high modulus polymeric matrix material.
8. A cable according to any preceding claim wherein the longitudinally welded tube or tubes of the core is/are laser welded.
9. A cable according to any preceding claim wherein each longitudinally welded metal tube is located within a respective one of the peripheral interstices between adjacent strength members.
10. A cable according to Claim 9 wherein the diameter of the or each said metal tube is such that the tube does not extend radially beyond the circle circumscribing the assembly of longitudinal strength members.
11. A cable according to any preceding claim wherein the or each said longitudinally metal tube of the core is provided on its outer surface with a non-metallic buffer layer.
12. A cable according to any preceding claim in which the core

incorporates a plurality of said longitudinally welded metal tubes, wherein the tubes, together with any buffer layers, where provided, are of uniform diameter.

13. A cable according to Claim 4 wherein the or each said metallic tube which is interspersed between members of the additional strength layer or layers is laser welded.

14. A cable according to any preceding claim wherein a water blocking compound is provided between the strength members and the metal tube or tubes of the core.

15. A cable according to Claim 2 or 3 wherein a water blocking compound is provided between the strength members of the additional strength layer.

16. A cable according to any preceding claim wherein a water blocking compound is contained within each metal tube of the core, and of the additional strength layer.

17. A cable according to Claim 16 wherein the water blocking compound within each metal tube is a thixotropic grease.

18. A cable according to any preceding claim wherein the strength members of the core are formed of steel.

19. A cable according to any preceding claim incorporating at least one electrical conductor covered with an insulating material and interspersed between stranded strength members.

20. An optical fibre cable substantially as shown in and as hereinbefore described with reference to Figure 1 or Figure 2 of the accompanying drawings.